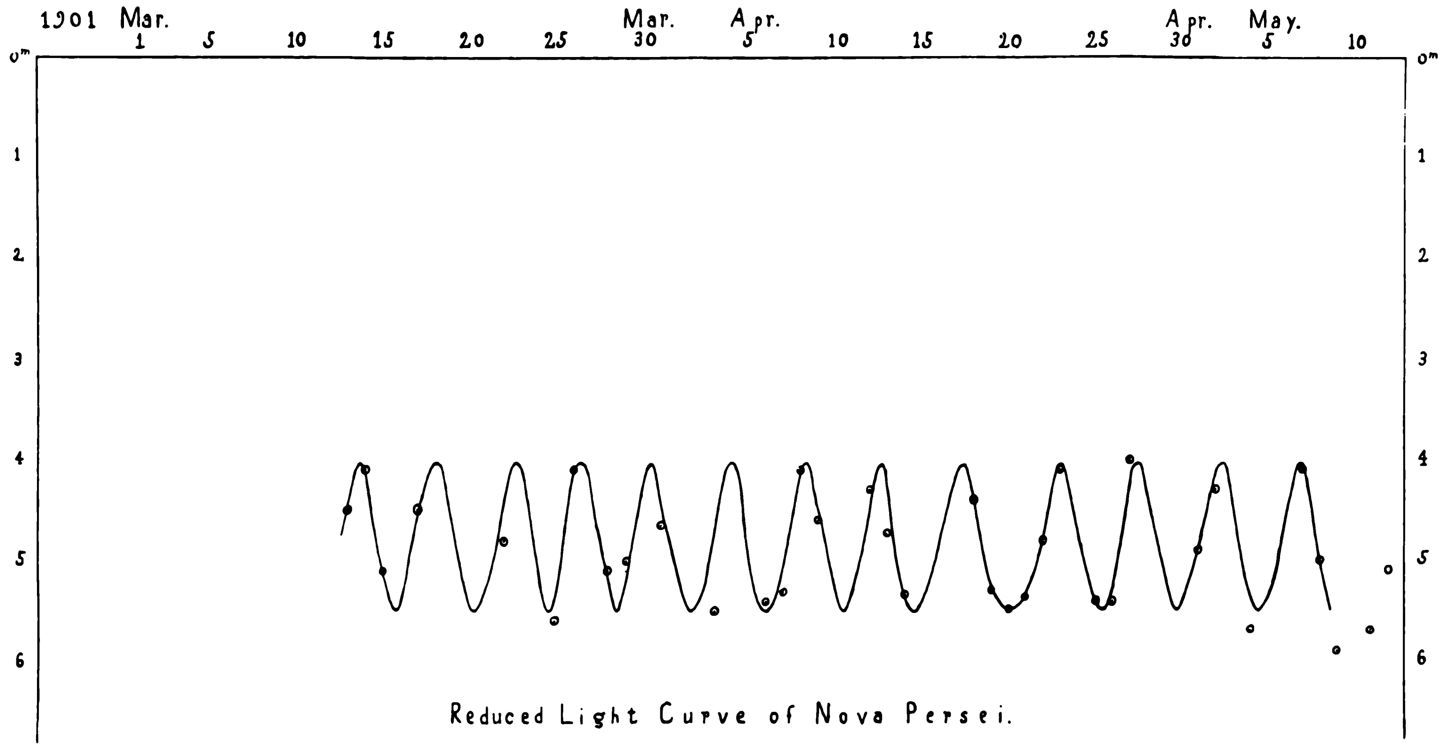

Reduced Light Curve of Nova Persei.

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LIGHT CURVE OF *NOVA PERSEI.*

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The new star in *Perseus* was observed at the Students' Observatory on nearly every clear night from February 24th to May 12th. Unfortunately obstructions in the northwestern horizon made it impossible to continue observations after the latter date. It was early noticed that the general decline of the star's brightness was interrupted by frequent increases of brightness. Toward the end of March the results gave strong evidence of a periodicity in the light changes, but it was not until the latter part of April that a sufficient number of observations had been obtained to warrant the announcement that *Nova Persei* had become a variable star of short period. On April 27th Professor LEUSCHNER sent the following telegram, in cipher, to the Harvard College Observatory:—

"Maxima of *Nova Persei* were observed at Berkeley by TOWNLEY, March 14th, March 26th, April 8th, and April 23d. Range, 1.3 magnitudes. Two, possibly three, secondary maxima."

We were informed that information to the same effect had already been received at Harvard College Observatory from Kiel, and consequently this telegram was not distributed by Professor PICKERING.

Subsequent observations have shown that the secondary maxima are probably of the same magnitude as the others, thus giving a period of about 4½ days from March 13th onward. No definite period can as yet be made out from the small fluctuations noticed previous to that time. The observations made subsequent to March 13th are represented in the accompanying

figure; the general decline in brightness having been eliminated in the following way. When the observations were plotted the following maxima were noticed:—

March	14,	$3^m.1$	April	23,	$4^m.3$
"	26,	$3\ .7$	May	7,	$4\ .3$
April	8,	$4\ .1$			

The maximum of March 14th was first brought down to that of March 26th by adding 0.6 magnitude to the value for March 14th and to each observation between March 14th and 26th $0^m.6$ times the ratio of "interval from date of observation to March 26th" and "twelve days." These magnitudes were then increased by the constant amount $0^m.4$ to bring them to the level of the maximum of April 8th. The observations between March 26th and April 8th were increased by proportional parts of $0^m.4$ in the same way as above. Magnitudes from April 8th to 23d were decreased by proportional parts of $0^m.2$, and all magnitudes after April 23d were decreased by $0^m.2$. Thus the five maxima were all brought to the same level, and the plotted result is seen in the accompanying figure. An inspection shows that the observations are very well represented by a curve which shows slight deviations from a symmetrical curve of a period of about 4.6 days. Very few portions of the curve have no observations to depend upon. The last six observations are somewhat uncertain on account of the small altitude, twilight, obstructing trees, etc. They seem to indicate that the general decline at that time was much more than $0^m.2$ of a magnitude. The twelve periods of the curve extend over 54.5 days, which gives 4.54 days for the average period; but if the last nine only are taken, a period of 4.61 days is obtained. The latter observations show a tendency towards a lengthening of the period. The information from Kiel, which was received here about May 5th, reported a three-day period between March 20th and 30th, when observations here were unfortunately interrupted by bad weather. A month later, however, my observations on ten consecutive days, April 18th to 27th, except April 24th, show clearly that a three-day period did not then exist.

The curve must not be taken too literally. It is not very likely that all of the maxima were of exactly the same height, nor all of the minima of the same depth, as is indicated in the curve drawn. The observations seem to show, too, that some of the turning-points are quite sharp and others rather flat, but the

number of observations at present available would not justify an attempt to draw anything more than a general curve. Although the period of this variable is short, still it is not likely that it will show the marked characteristic, great regularity, of the two classes of short-period variables. It will be found rather, I think, to behave like the long-period variables in which exact uniformity of changes is always lacking. The second, third, fifth, and sixth maxima; the first, second, fifth, and seventh minima have but few observations to support them, and I should not be surprised to see these parts of the curve considerably modified when other observations become accessible.

OBSERVATIONS.

The observations were made by the same methods that I have used in previous variable star-work, and which are fully explained in the Publications of the Washburn Observatory, Vol. VI, Part 3. Both of the standard methods were used. After the first few nights the comparison-stars employed were selected from the charts and catalogues sent out from the Georgetown College Observatory. The magnitudes of the comparison-stars have been carefully investigated. After examining several sources, it was decided to use the magnitudes given in the later volumes of the Harvard College Observatory photometric work. It is essential that the magnitudes adopted shall conform to some definite system, and this can be obtained better perhaps by taking the results of one investigation than by combining the results of several; at least the latter method could be made the more efficient only by an elaborate discussion, which it did not seem necessary to make at this time. The comparison-stars used are given in the following table; the adopted magnitudes having been obtained from volumes 44 and 45 of the Annals of the Harvard College Observatory. The magnitude of ρ *Persei* was obtained from comparisons on March 10th, 11th, 12th, and 14th.

COMPARISON - STARS.

Reference Letter.	Star.	Adopted Magnitude.	Reference Letter.	Star.	Adopted Magnitude.
a	α *Aurigæ*	0.24	*f*	α *Geminorum*	1.61
b	β *Orionis*	0.30	*g*	α *Persei*	1.85
c	α *Canis Minoris* ..	0.46	*h*	β *Andromedæ*....	2.17
d	α *Tauri*..........	1.09	*i*	α *Ursæ Minoris* ..	2.20
e	β *Geminorum*	1.25	*j*	γ *Cassiopeiæ*......	2.22

Reference Letter.	Star.	Adopted Magnitude.	Reference Letter.	Star.	Adopted Magnitude.
k	γ *Andromedæ*.	2.26	*s*	ρ *Persei*.	3.42
l	β *Persei*.	2.30	*t*	ν *Persei*.	3.90
m	β *Cassiopeiæ*.	2.44	*u*	κ *Persei*	4.04
n	δ *Cassiopeiæ*.	2.78	*w*	ι *Persei*	4.20
o	ζ *Persei*.	2.83	*x*	*Flamsteed 32*. . . .	5.13
p	ε *Persei*	2.88	*y*	*Flamsteed 36*. . . .	5.33
q	γ *Persei*.	3.05	*z*	*Flamsteed 30*. . . .	5.39
r	δ *Persei*.	3 06	*a′*	B. D. + 44° 734	6.48

Following are the observations upon which the foregoing results depend. The weights of the individual observations have been assigned, arbitrarily, after considering the circumstances and conditions under which the observations were made. The chief factors which affect the accuracy of such observations are: distance between the stars compared; number of steps estimated, or difference in magnitude of the two comparison-stars used; difference in color of the stars. The observations made by the step-method have been reduced on the assumption that one step equals one tenth of a magnitude, which seems justified by the fact that in the long series of observations made at the Washburn Observatory several years ago, the value of one step was found to be 0.92 of a magnitude. v stands for *Nova Persei*. In the column headed "instrument," E stands for naked-eye observations; G for field-glasses; F for 4.5 centimeter finder of equatorial; S for surveyor's transit; C for 15.4 centimeter Clark equatorial.

OBSERVATIONS.

Date. G. M. T.	Comparisons.	Nova.	Wt.	Weighted. Mean.	Instrument.	Remarks.
1901		m		m		
Feb 24.69...	v $\overset{=}{<}$ b	0.35	2	...	E	
	a 5.e	0.75	2	...	E	
	a 3–4 e	0.59	2	...	E	Made by R. A. Curtiss.
	a 2–3 i	0.73	1	0 6	E	
Feb. 25.69...	b 3 i	0.84	1	...	E	
	a 8–9 e	1.10	2	...	E	
	v = e	1.25	1	...	E	Position difficult.
	b 6–5 l	0.73	1	...	E	Moon interferes.
	c 6 d	0.84	1	1.0	E	Moon interferes.

Date. G. M. T.	Comparisons.	Nova.	Wt.	Weighted. Mean.	Instrument.	Remarks.
1901		m		m		
Feb. 26.77...	d 3-4 i	1.47	2	...	E	
	b 8 i	1.84	1	...	E	
	e 5 i	1.72	2	...	E	
	e 4 f	1.78	2	1.7	E	
Feb. 27.63...	d 8-9 i	2 03	2	...	E	
	v = g	1.85	3	...	E	
	d 7 k	1.91	2	...	E	
	h 4 k	2.21	2	2.0	E	
Mar. 1.65...	g 7-8 l	2.19	...	2.2	E	Clouds prevent other observations.
Mar. 2.65...	g 4 l	2.03	2	...	E	
	g h 1 k v 2 l	2.10	4	...	E	
	i 2 v	2.40	1	2.1	E	
Mar. 3.67...	l 3 p	2 47	1	...	E	
	l 1-2 r	2.41	1	...	E	
	g 2 h i 1 k 2 l 2 v	2.60	3	2.5	E	
Mar. 4.65...	g 3 r	2.21	1	...	E	
	g 3 p	2.16	1	...	E	
	4 n	2.44	1	2.3	E	
Mar. 5.65...	v l j	2.26	5	...	E	v as red as d.
	m 1 v	2.44	2	...	E	
	i 1-2 v	2.35	2	2.3	E	
Mar. 6.65...	v 3 s	3.12	1	...	E	
	l 7 s	3.08	1	3.1	E	
Mar. 8.63...	l 4 s	2.74	...	2.7	E	
Mar. 10.75...	l 3-4 s	2.69	1	...	E	
	n 2 v	2.98	2	...	E	
	l 7-8 p	2.73	3	...	E	
	l 7 r	2 83	3	2.8	E	
Mar. 11.69...	l 9 s	3.32	1	...	E	
	v 1 s	3.32	1	...	E	
	r 1 v	3.16	3	...	E	
	p 2-3 v	3.13	2	...	E	
	p 4 u	3 34	1	3.2	E	
Mar. 12.75...	p v 2 r	2.87	4	...	E	
	p 1 u	3.00	1	...	E	
	q 1-2 v	3.20	2	...	E	
	l 6 s	2.97	1	3.0	E	
Mar. 13.7 ...	p 4 u	3 34	2	...	E	
	r 5-6 u	3.60	3	...	E	
	p 5 t	3.39	2	...	E	
	r 6-7 t	3.60	3	3.5	E	

Date. G. M. T.	Comparisons.	Nova.	Wt.	Weighted. Mean.	Instrument.	Remarks.
1901		m		m		
Mar. 14.71...	r 1 v	3.16	3	...	E	
	p 2 t	3.08	3	...	E	
	q 1 v	3.15	2	...	E	
	l 7 s	3.08	1	...	E	
	o v	2.83	2	3.1	E	Stars twinkle badly.
Mar. 15.77...	u 2 t 1 v	4.14	...	4.1	G	
Mar. 17.71...	r 7 t	3.65	3	...	G	
	r 5 u	3.55	3	...	G	
	p 7 t	3.59	3	...	G	
	p 5 u	3.46	2	3.6	G	
Mar. 22.74...	v w	4.20	3	...	G	
	u 3 x	4 37	2	...	G	
	t 2–3 v	4.15	2	4.2	G	
Mar. 25.65...	x 1 v	5.23	2	...	G	
	u 7–8 z	5.05	1	...	G	Difficult with field glasses.
	x 2 y	5.17	2	5.2	G	
Mar. 26.71...	v 2 u t	3 77	2	...	F & S	
	r 6–7 u	3.70	1	3.7	F & S	
Mar. 28.67...	u 6–7 x	4 75	1	...	G	
	t 7–8 x	4.82	1	4.8	G	
Mar. 29.69...	u 5 x	4.59	1	...	G	
	t 7 x	4.76	1	4.7	G	
Mar. 31.67...	u 3 x	4.37	1	...	G	
	t 4 x	4.39	1	4.4	G	
Apr. 3.66...	x 3–4 z	5.22	3	...	G	Difficult with field glasses.
	y 3 v	5.66	1	5.3	G	
Apr. 6 7 ...	x 8 z	5 34	3	...	G	v just visible without glasses.
	v 2 z	5.19	2	...	G	
	v z	5 33	3	5.3	G	
Apr. 7.7 ...	x 8 z	5.34	1	...	G	
	v y	5.33	1	5.3	G	
Apr. 8.70...	t 1 u 1 v	4 12	...	4.1	G	
Apr. 9.67...	t 6–7 x	4 70	1	...	G	
	u 5 x	4.59	1	4.6	G	
Apr. 12.7 ...	u 2–3 v	4.29	...	4.3	G	Uncertain on account of clouds.
Apr. 13.69...	t 7 x	4.76	1	...	G	
	u 7–8 x	4.85	1	4.8	G	
Apr. 14.67...	v y	5.33	2	...	G	
	z 2 v	5.59	1	5.4	G	

Date. G. M. T.	Comparisons.	Nova.	Wt.	Weighted. Mean.	Instrument.	Remarks.
1901		m		m		
Apr. 18.67...	u 5 x	4.59	1	...	F	
	t 4 x	4.38	1	4.5	F	
Apr. 19.67...	v z	5.39	3	...	G	
	y 2 v	5.53	2	5.4	G	
Apr. 20.67...	z 2 v	5.59	...	5.6	G	
Apr. 21.67...	v z	5.39	2	...	F	
	y 2 a′	5.56	1	...	F	
	y 2–3 v	5.58	1	5.5	F	
Apr. 22.68...	v 1 x	5.03	3	...	F & C	
	u 8 x	4.91	2	5.0	F & C	
Apr. 23 67...	t 3 x	4.27	1	...	F & C	
	u 2 x	4.26	1	4.3	F & C	
Apr. 25.68...	y 2 a′	5.56	1	...	F & C	
	z 2–3 v	5.64	1	5.6	F & C	
Apr. 26.67...	y 3–4 a′	5.73	2	...	F & C	
	z 2 v	5.59	3	5.6	F & C	
Apr. 27.67...	t 3–2 x	4.21	1	...	G F & C	
	u 2 x	4 26	1	...	G F & C	
	u 2 v	4.24	1	4.2	G F & C	
May 1.67...	v x	5.13	...	5.1	F & C	
May 2.68...	t 5 x	4.51	1	...	F & C	
	u 4 x	4 48	1	4.5	F & C	
May 4.68...	y 7 a′	6.14	1	...	F & C	Seeing poor.
	z 3–4 v	5.74	1	5.9	F & C	
May 7 68...	t 3 x	4.27	1	...	F	
	u 2–3 x	4.26	1	4.3	F	
May 8.68...	x 5 y	5.23	...	5.2	F & C	
May 9.68...	y 7 a′	6.14	...	6.1	F & C	Difficult—low altitude.
May 11.68...	y 5 a′	5.90	...	5.9	F & C	Very uncertain.
May 12.68...	v y	5.33	..	5.3	F & C	Very uncertain.

NOTE.—Since the above was written I have received through the courtesy of Director CAMPBELL, of the Lick Observatory, the results of a very complete series of observations made by Mr. AITKEN. Bulletin No. 17 of the Yerkes Observatory, containing Mr. PARKHURST's observations, and No. 6, Vol. LXI, *Monthly Notices of Royal Astronomical Society*, containing observations by the Oxford observers, have been

received also. These observations have been plotted, and in general confirm the curve from March 20th on, strengthening many of its weak points. The eighth and eleventh maxima and the twelfth minimum are the only ones which are not strengthened by additional observations. Between March 10th and 16th, however, the observations do not support the curve as drawn. They show either a period of about one day, or else some large errors of observation. My observation of April 3d, which falls considerably from the curve, is confirmed by one made by Mr. PARKHURST showing that the minimum was delayed about a day.

These additional observations show, as I expected they would, that the actual curve is considerably more irregular than the one drawn.

Mr. AITKEN's observations, which extend to May 19th, give two additional maxima, May 13.5 and about May 18.5, the last on the curve of the accompanying figure being May 7.7, G. M. T. This shows almost conclusively, what was previously suspected, that the period is lengthening.

A preliminary investigation of all the data available leads to the following conclusions:—

1. From February 24th to March 19th the brightness of the star decreased in an irregular way about three magnitudes, but there is strong evidence of a gradually lengthening period throughout this time. A period of about a day from March 10th to 15th seems almost certain.

2. From March 20th to May 19th there was a very slight general decline in brightness, but a well-marked period, which gradually lengthened from three and a half to five days. The range between maxima and minima has an average value of about 1.5 magnitudes.

A modification of the tide theory offers an explanation of the phenomena observed in *Nova Persei.* Suppose a near approach between two bodies occurs; one a body of large mass, which has cooled so that a thin crust has been formed, making the body non-luminous, a condition in which it is thought our Sun will be about 20,000,000 years hence; the other a body of small mass and solid, like the Moon, for example. Let the directions and velocities of motion of these two bodies be such that a very close approach, not a collision, takes place. Suppose the masses of the bodies are such that the larger is not sensibly disturbed in its motion, but that the smaller is profoundly disturbed. Its orbit will be changed from a straight line to a parabola, an hyperbola, or a very elongated ellipse, depending upon the initial velocity. At a very near approach of the two bodies the smaller will be swept rapidly around the larger, like a comet around the Sun; the attraction of the smaller may be sufficient to burst the crust of the larger and produce a sudden outburst of the heated matter within. As the smaller body moves rapidly around the larger, this rent in the crust will be carried forward and the light of the star will increase rapidly, and a tremendous tidal-wave will have been set up. As the smaller body moves away from the larger, the tidal-wave will continue to move, sweeping away the accumulated vapors, thus producing a maximum of brightness at each return of the wave to the line of sight of the observer. On account of internal friction, however, the velocity of propagation of this wave will continually decrease and the period of fluctuation in brightness will gradually increase, and the star will finally settle down to its former state.

This explanation is offered tentatively. I hope soon to thoroughly investigate the suggestions here made.